Brazilian Journal of Biology®

ISSN 1519-6984 (Print)
ISSN 1678-4375 (Online)

Original Article

Opiliofauna (ARACHNIDA: OPILIONES) of the Atlantic Forest in the state of Paraná, Brazil

Opiliofauna (ARACHNIDA: OPILIONES) de Mata Atlântica no estado do Paraná Brasil

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Abstract

Opiliones are arachnids that provide different services in terrestrial ecosystems, especially in tropical forests, which justifies inventory studies to better understand the occurrence and distribution of these arthropods in Brazil, since little is known about the harvestmen fauna in Conservation Units such as in the state of Paraná. In this context, the objective of the present study was to survey the harvestmen fauna at the Iguaçu National Park (PARNA) and in the Bela Vista Biological Refuge (BVBR), from September 2021 to May 2022, using a sampling effort of 40 hours in the BVBR, and 66 hours at the PARNA Iguaçu. Ten species/morphospecies were recorded, highlighting a new occurrence for Brazil, the species *Opisthoplatus vegetus*. The present study reduces the information gap about Opiliones in the state, which reaffirms the importance of Conservation Units for the protection of the biota in the state of Paraná.

Keywords: arachnids, tropical forests, harvestmen.

Resumo

Opiliões são aracnídeos que prestam diferentes serviços nos ecossistemas terrestres, sobretudo nas florestas tropicais, o que justifica trabalhos de inventários para melhor conhecer a ocorrência e distribuição desses artrópodes no Brasil, pois pouco se conhece da fauna de opiliões em Unidades de Conservação no estado do Paraná. Nessa perspectiva, o objetivo do presente estudo visa inventariar a fauna de opiliões no Parque Nacional do Iguaçu (PARNA Iguaçu) e no Refúgio Biológico Bela Vista (RBBV), no período de setembro de 2021 a maio de 2022, com esforço amostral de 40 horas para RBBV e 66 horas PARNA Iguaçu. Foram registradas 10 espécies/morfoespécies, com destaque para uma nova ocorrência para o Brasil, a espécie *Opisthoplatus vegetus*. O presente estudo diminui a lacuna de informações sobre opiliones no estado e reafirma a importância da Unidades de Conservação para proteção da biota do Paraná.

Palavras-chave: aracnídeos, florestas tropicais, opiliões.

1. Introduction

The Atlantic Forest is considered one of the most important forests in the world due to its species richness (Farias et al., 2007), with high endemism of plants (Rech-Filho et al., 2009) amphibians, reptiles, birds, and mammals (Rocha et al., 2004; Rocha et al., 2005) in addition to invertebrates, such as insects (Souza et al., 2020) and harvestmen (Pinto-Da-Rocha et al., 2005). However, this biome has suffered reduction and/or alteration in its ecosystems, which is highly fragmented (Tabarelli et al., 2010), considered, therefore, one of the most threatened in the world, and for this reason, it is one of the 25 world hotspots (Myers et al., 2000).

The order Opiliones contains about 6,676 species (Kury, 2023), being the fourth most diverse order of the class Arachnida, after Acariformes, Parasitiformes, and Araneae (Harvey, 2007; Van Dam et al., 2019; WSCA, 2023) distributed on all continents except Antarctica.

Harvestmen perform different ecosystem services as a component of terrestrial trophic chains, acting as prey and predators (Cook et al., 2013; Rubim et al., 2021), accelerating the process of decomposition of organic matter and contributing to the cycle of nutrients in ecosystems (Moore et al., 1991; Acosta and Machado, 2007).

The center of occurrence of these arachnids are tropical forests (Pinto-Da-Rocha et al., 2005), such as the Brazilian Atlantic Forest, which is home to the greatest richness on the planet, (Kury, 2023) and which concentrates most studies on these arthropods, particularly in the states of Minas Gerais, Rio de Janeiro and São Paulo (Bragagnolo and Pinto-Da-Rocha, 2003; Bragagnolo et al., 2007; Resende et al., 2012a, 2012b; Costa et al., 2020; Lima et al., 2022; Pádua et al., 2023), but there is little information for other Brazilian states, such as Paraná.

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Received: May 5, 2023 – Accepted: August 22, 2023

The harvestmen fauna in that state comprises 103 species, the result of efforts of different studies in the period from 1943 to 2021 (Soares, 1943, 1944, 1945, 1954; Soares and Soares, 1945, 1946, 1947a, b; Pinto-Da-Rocha, 1993, 1996; Kury, 2003; Mestre and Pinto-Da-Rocha, 2004; Acosta et al., 2007; Gomes et al., 2021), however, many locations, including Conservation Units (CUs), do not have information on their opiliofauna. In this scenario, the present study aimed to survey the harvestman fauna in two Conservation Units, as well as to expand information on the composition of the taxon in the state of Paraná.

2. Material and Methods

The study was carried out in two Conservation Units in western Paraná: the Iguaçu National Park (PARNA Iguaçu) (25°37'28.7"S 54°28'18.5"W), and the Bela Vista Biological Refuge (BVBR) (25° 26'51.3"S 54°33'09.4"W). Collections were carried out from September 2021 to May 2022, with 40 hours in 20 sampling days in the BVBR, and 66 hours in 33 days at PARNA Iguaçu, totaling 86 hours of work in the field to collect harvestmen, in addition to data of a sporadic collection of Ph.D. Ricardo Pinto da Rocha, University of São Paulo, in 1997, near the headquarters of the Iguaçu National Park.

The Iguaçu National Park (PARNA) is 85,162 hectares in area, with the predominance of the Semideciduous Seasonal Forest (ICMBIO, 2018), which constitutes one of the most important conservation areas of the Atlantic Forest in Brazil. Areas were sampled in the municipalities of Capanema (25°32'02.5"S 53°48'41.5"W), Céu Azul (25°32'10.1"S 53°45'06.7"W), and Foz do Iguaçu (25°37 '28.7"S 54°28'18.5"W).

The Bela Vista Biological Refuge (BVBR) is 1,780 hectares in area, with Semideciduous Forest formations, located in the municipality of Foz do Iguaçu, state of Paraná, southern Brazil (ITAIPU, 2022).

Harvestmen were collected from 7:00 pm to 9:00 pm, the period of greatest activity for these arachnids (Resende et al., 2012a), therefore, two hours of daily sampling effort per researcher, using the active search method, as suggested by Pinto-Da-Rocha and Bonaldo (2006) which consists of walking along pre-existing trails in the forest areas close to water courses, and anthropized, such as around the lodgings and on roads, inspecting banks, litter, cavities in trees, decomposing trunks on the ground, walls and abandoned human constructions, as well as rubble, such as tiles, boards, and bricks (Figure 1). This procedure was performed in the same way at PARNA Iguaçu and BVBR.

Figure 1. Sampled areas at the Iguaçu National Park (A and B) and active search methodology used to collect Opiliones in the Bela Vista Biological Refuge (C and D), state of Paraná, Brazil.

Harvestmen found were sacrificed and stored in 70% alcohol, sent to Ph.D. Ricardo Pinto da Rocha, University of São Paulo, for identification. One specimen was deposited in the zoology collection of the University of São Paulo (catalog number: MZSP-15950) and the other specimens sampled in this study in the biological collection of social wasps (CBVS) (list number: 08358- 2021 to 08685-2021) of the Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas Gerais, Campus Inconfidentes. The study was authorized by ICMBio, under license SISBIO Number 76084-3.

3. Results and Discussions

Combining the two locations, a total of 671 specimens of six species and four morphospecies were collected, which were distributed in three families (Table 1). Highlight for *Opisthoplatus vegetus*, which has its first record in Brazil, and which was, together with *Geraecormobius sylvarum* Holmberg, 1887, (Figure 2) the most abundant species (84.2% of the total) (Table 1).

The Bela Vista Biological Refuge and Iguaçu National Park (PARNA), both with eight species, represent the greatest richness of a locality in Paraná (Pinto-Da-Rocha, 1993; Gomes et al., 2021). The recorded richness (10) in two areas is a reflection of the predominant phytophysiognomy in these areas, the Semideciduous Seasonal Forest (ICMBIO, 2018), also known as the interior Atlantic Forest, which has lower humidity and higher deciduousness in the dry season, with about 50% deciduous species, compared to another forest formation in the biome, the Ombrophilous Forest, which commonly occurs along the coast of the country (IBGE, 2012).

A deciduousness of around 50% (Oliveira-Filho, 2006) increases soil exposure to sunlight during the dry season in Semideciduous Seasonal Forests, decreasing humidity, which negatively affects the distribution of harvestmen, which dehydrate very quickly (Santos, 2007) and therefore depends on the availability of humid microhabitats for their survival (Resende et al., 2012a; Proud et al., 2012).

Table 1. Families, species, and morphospecies of harvestmen (Opiliones) collected at the Iguaçu National Park (PARNA) and the Bela Vista Biological Refuge (RBV), western state of Paraná, Brazil.

Family	Species and Morphospecies	PARNA Iguaçu	RBV
Gonyleptidae	*Opisthoplatus vegetus* (Canals, 1939)	344	50
Gonyleptidae	*Geraecormobius sylvarum* Holmberg, 1887	100	71
Gonyleptidae	*Eusarcus hastatus* Sørensen, 1884	20	01
Gonyleptidae	*Hernandaria armatifrons* (Roewer, 1917)	03	00
Gonyleptidae	*Ogloblinia loretoensis* Canals, 1933	01	01
Gonyleptidae	*Mischonyx squalidus* Bertkau, 1880	00	05
Gonyleptidae	*Discocyrtus* sp.	07	00
Gonyleptidae	*Kazaddum* sp.	00	12
Cosmetidae	*Gryne* sp	23	01
Sclerosomatidae	Gagrellinae gen. sp.	22	31
Richness		08	08
Abundance		499	172

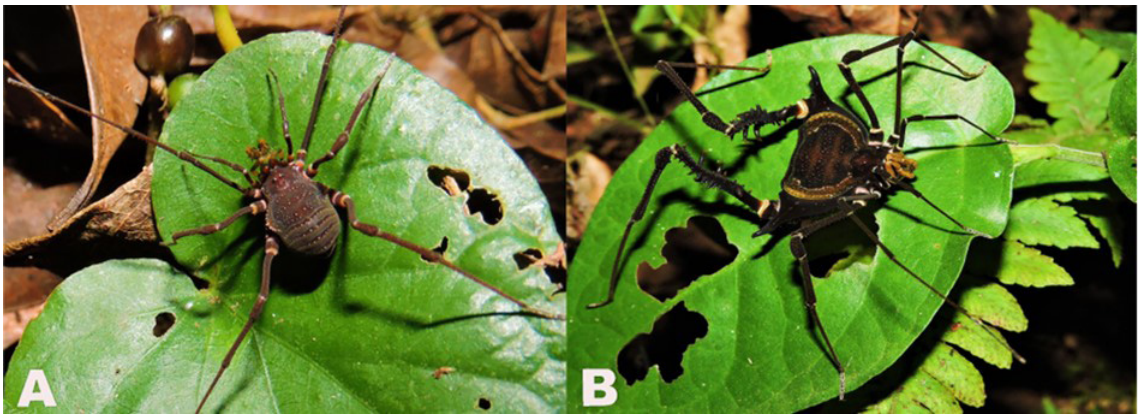

Figure 2. Male (A) and female (B) of *Geraecormobius sylvarum* (Opiliones) collected at the Iguaçu National Park and in the Bela Vista Biological Refuge, state of Paraná, southern Brazil.

This humid condition may explain why the richness of the present study is similar to other studies also carried out in the same phytophysiognomy (Semideciduous Seasonal Forest) in the Atlantic Forest, which record about five to 14 species per location (Nogueira et al., 2019; Resende et al., 2012a; Ferreira et al., 2020; Gomes et al., 2021; Andrade et al., 2022), except for Costa et al. (2020), who recorded 34 species in the south of Minas Gerais but sampled different locations in 14 municipalities. It is important to highlight that these studies have different sampling methodologies, either number of hours or methods (active or passive, via traps), and yet, the richness was similar, which reinforces our hypothesis about the effect of humidity as a cause of similar wealth.

According to Pinto-Da-Rocha et al. (2005) and Nogueira et al. (2019), who investigated the biogeography of harvestmen in the Atlantic Forest, coastal areas that are home to Ombrophilous Forest formations in the south and southeast of the country show a higher richness of harvestmen compared to areas of Semideciduous Forest, a reflection of humidity as already discussed, but also due to its geological, evolutionary and environmental history, as the Coastal Ombrophilous Forest was subjected to expansion and retraction events in its area during the glaciation period, which promoted speciation, mainly during the geographic isolation processes, and increased diversity, during expansion events (Behling and Lichte, 1997; Silva et al., 2016).

The abundance of Gonyleptidae species in the studied areas was expected, as they constitute the most diverse and abundant family in the Atlantic Forest in the southern and southeastern regions of Brazil (Kury, 2003), as observed in other studies in the same biome (Bragagnolo and Pinto-Da-Rocha, 2003; Nogueira et al., 2019; Resende et al., 2012a, 2012b; Ferreira et al., 2019; Ferreira et al., 2020; Costa et al., 2020; Gomes et al., 2021; Andrade et al., 2022; Lima et al., 2022; Pádua et al., 2023). Until then, *O. vegetus* had been recorded only in the province of Misiones, Argentina (Soares and Soares, 1954; Ringuelet, 1959; Galiano and Maury, 1979; Kury, 2003) (Figure 3), its occurrence reported here may indicate a possible endemism of this species, since they are only found in areas of Semideciduous Forest and Mixed Ombrophilous Forest, which are phytophysiognomies of the Atlantic Forest, the biome with the highest endemism of harvestmen on the planet (Pinto-Da-Rocha et al., 2005), which suggests that this species may occur in other phytophysiognomies of the biome in Brazil, or may be endemic to these forest formations (Silva et al., 2015), since the low dispersal capacity of these arachnids (Mestre and Pinto-Da-Rocha, 2004) increase the endemism of the group, as already demonstrated for several species recorded in the Atlantic Forest (Pinto-Da-Rocha et al., 2005; Silva et al., 2015).

Regarding the geographic distribution of the other species (Table 2) occurring in the areas of the present study, are probably because they are typically found in areas of the Atlantic Forest in southern and southeastern Brazil (Gnaspini, 1996; Tavares, 1980; Kury, 2003; Acosta et al., 2007; Silva, 2008; Hara and Pinto-Da-Rocha, 2010).

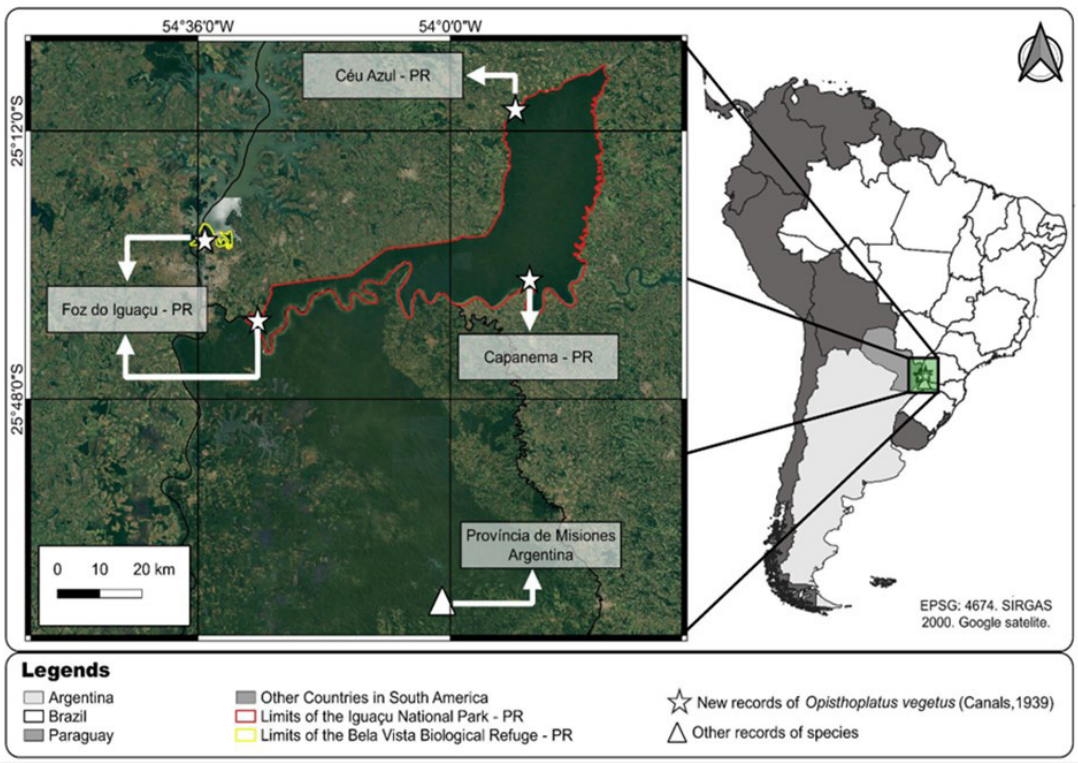

Figure 3. Geographic distribution of *Opisthoplatus vegetus* in Argentina and the first record in Brazil, in the municipalities of Capanema, Ceú Azul and Foz do Iguaçu, state of Paraná.

Table 2. Geographic distribution, biome, and states of occurrence (authors and year of published studies) of Opiliones species collected at the National Park Iguaçu (PARNA) and in the Bela Vista Biological Refuge (BVBR) Bela Vista, western state of Paraná, Brazil.

Species	Biomes	States	Authors and year
Ogloblinia loretoensis	Atlantic Forest	São Paulo, Paraná, Santa Catarina and Rio Grande Do Sul	Tavares (1980); Gnaspini (1996); Kury (2003)
Geraecormobius sylvarum	Atlantic Forest	Paraná, Santa Catarina and Rio Grande Do Sul.	Kury (2003); Acosta et al. (2007)
Eusarcus hastatus	Atlantic Forest and Cerrado	São Paulo Minas Gerais, Espírito Santo and Minas Gerais	Kury (2003); Hara and Pinto-da-Rocha (2010)
Hernandaria armatifrons	Atlantic Forest	São Paulo Minas Gerais, Santa Catarina, Paraná and Rio Grande do Sul	Silva (2008); Zampaulo and Simões (2022)
Mischonyx squalidus	Atlantic Forest and Cerrado	São Paulo, Minas Gerais, Paraná, Rio de Janeiro, Paraná and Espírito Santo	Mestre and Pinto-Da-Rocha (2004); Gueratto et al. (2021); Pádua et al. (2023)

In addition, *M. squalidus* exclusive to the Bela Vista Biological Refuge (BVBR), may be present because this area harbors a mosaic of regeneration stages and areas under human pressure, as this species shows a synanthropic behavior, and is found in residential and agricultural areas, and tolerates modified environments (Mestre and Pinto-Da-Rocha, 2004; Nogueira et al., 2019; Gueratto et al., 2021).

4. Conclusion

Our results expand the information on the taxon in the state of Paraná, in addition to a new record for Brazil, *Opisthoplatus vegetus*, which reaffirms the importance of these Conservation Units in protecting the biota of the state of Paraná.

Acknowledgements

To SISBIO, for granting licenses 76084-3. To IFSULDEMINAS, Campus Inconfidentes, MG, to IFPR, Campus Umuarama, PR. To the Territorial Intelligence Center (NIT) of the Itaipu Technological Park Foundation (FPTI) for financial support through agreement 4500049462, signed between Binational ITAIPU and FPTI; to the Research sector of the Iguaçu National Park for receiving the researchers, and to the Chico Mendes Institute for Biodiversity Conservation (ICMBio), especially the brigade members, for logistical support; To the interns for their help in the field and to Professor Ph.D. Ricardo Pinto da Rocha, USP, for identifying the material.

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